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Accessibility and Older and Foreign Populations: Exploring Local Spatial Heterogeneities across Italy

Massimo Armenise [1], Federico Benassi [2,*], Maria Carella [3] and Roberta Misuraca [3]

[1] Italian National Institute of Statistics (ISTAT), 00184 Rome, Italy; massimo.armenise@istat.it
[2] Department of Political Science, University of Naples Federico II, 80138 Naples, Italy
[3] Department of Political Science, University of Bari Aldo Moro, 70121 Bari, Italy; maria.carella1@uniba.it (M.C.); roberta.misuraca@uniba.it (R.M.)
* Correspondence: federico.benassi@unina.it

Abstract: The interplay between accessibility and population change is a relatively new subject in Italian academic research. Along with social and economic factors such as regional economic prosperity, the ease of movement inside and outside an area can play a pivotal role in shaping population dynamics. This study seeks to explore the spatial distribution and spatial relationships of three indicators, including one related to real accessibility (RAI) and two others related, respectively, to the shares of the older population (SOP) and of the foreign population (SFP). An exploratory spatial data analysis is, therefore, conducted at the local level using Italian municipalities as the statistical units for the empirical analysis. Local univariate spatial autocorrelation analysis is used together with a regression analysis based on ordinary least squares (OLS) and geographically weighted regression (GWR) models. The results provide valuable insights into the local heterogeneity that characterizes the distribution of each indicator and the local relationship between them, highlighting the importance of thinking locally in quantitative social sciences.

Keywords: local demography; spatial analysis; territorial imbalances; foreign population; older population; accessibility; municipalities; Italy

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1. Introduction

In Italy, demographic dynamics and behaviors, coupled with socio-economic phenomena, have long followed different trends and characteristics according to the geographic contexts of reference (Billari and Tomassini 2021). Significant and deep-rooted territorial imbalances over time have affected many parts of the country—mountainous regions versus coastal areas, inland versus central areas, and rural versus urban and metropolitan areas—undermining the nation's territorial and social cohesion (Barca 2019; Annunziata et al. 2024; Campagnucci and Morettini 2024).

These differences are amplified at the local level, occurring within a macro framework that has traditionally been defined by the so-called north–south divide. This division juxtaposes the economically more dynamic, more industrialized, and more urbanized north with the south, which is more agricultural, less urbanized, and more vulnerable and fragile in socio-economic terms (Salvati 2014; Armenise et al. 2022).

Even at a demographic level, these differences are persistent and deeply rooted to the point that they have recently been defined, within the framework of Italian demographic exceptionalism, as true spatial inequalities (Benassi et al. 2021a). The causes of such inequalities are multiple and complex, originating from Italy's very demographic history (Rosina and Impicciatore 2022), as well as from the particularity of its geography and geomorphology, characterized by a pronounced heterogeneity and a multitude of small, often isolated, marginal and depopulated municipalities (Golini et al. 2000; Viesti 2021; Benassi et al. 2024)

In this context, the level of transport infrastructure and, more specifically, land accessibility of the different local contexts becomes a potent force in shaping the overall dynamics and the multiple challenges that territories face, including those related to economic and demographic growth/decline (Vickerman et al. 1999; Shelukdov et al. 2020). Indeed, remote areas or inner areas—that are very often less accessible—are particularly susceptible to poverty, social exclusions, and depopulation (Benassi et al. 2021a; Panagiotopoulos and Kaliampakos 2024).

The absence of adequate health and education infrastructure is a key factor in deterring young people from settling in these regions and, at the same time, acts as a push factor for those who already reside there (La Bianca and Navarro Valverde 2019; Staniscia and Benassi 2018; Muti 2023). This is why regional development policies often aim to mitigate spatial disparities through the enhancement of transport infrastructure, although with variable results (Panagiotopoulos and Kaliampakos 2024)

Italy, from this point of view, is an example of extreme interest. In fact, even from the perspective of accessibility, the gaps are relevant both between different macro-territorial contexts (with the north generally being more accessible than the south) and especially within these contexts (Campagnucci and Morettini 2024). These inequalities have significant repercussions on demographic dynamics, particularly on depopulation processes, as shown in several empirical studies related to other southern European countries (Panagiotopoulos and Kaliampakos 2024; Melo et al. 2022; Rodríguez-Rodríguez and Larrubia Vargas 2022; Alamá-Sabater et al. 2019, 2021; Sánchez-Mateos and Pulpón 2021). Although it has also been observed in Italy that the presence of essential services closely linked to accessibility—such as elementary schools—are determinants of demographic growth/decline processes (Benassi et al. 2023), to the best of our knowledge, studies that have so far correlated the accessibility of territorial contexts with their demographic characteristics and/or demographic dynamics at a local scale are almost absent. This is also due to the limited availability of accessibility indicators provided by official statistics (Chiocchini and Cruciani 2009) up until now.

Based on these premises, the main purpose here is to investigate—at the local scale for Italy—the spatial dimension of land accessibility, the share of the older population, and the share of the foreign population. These last two indicators are closely linked to the demographic phenomenon generally associated with accessibility, namely depopulation. In fact, depopulation is often observed as a self-perpetuating process (Reynaud et al. 2020) that is intimately linked to aging (Reynaud and Miccoli 2023), but also as something that can at least be slowed down by foreign immigration (Gesano and Strozza 2011).

Understanding how the accessibility of local contexts correlates with the aging process and foreign presence (i.e., international migration) is, therefore, an important issue. Indeed, aging and foreign presence have a significant impact on population growth and age structure, serving as focal points of interest in demographic and socio-economic phenomena (Harper 2014; Reitz 2002). Moreover, both the older and foreign populations exhibit specific geographical distributions related to the different socio-economic characteristics of the local host contexts, posing important challenges in terms of spatial planning and regional development (Reynaud and Miccoli 2023; Strozza et al. 2016; Tragaki and Rovolis 2014). In this regard, it is useful to recall that aging and foreign presence (international migrations) are two of the most significant demographic processes in the current Italian demographic landscape (Billari and Tomassini 2021).

Empirically, we focused on the spatial distributions of an accessibility indicator and two demographic indicators related to aging and foreign presence. The aims of the paper are (i) to evaluate the existence of spatial patterns in the geographical distribution of these three indicators and (ii) to measure the relationships—also from a spatial perspective—between accessibility and the degree of aging and between accessibility and foreign presence.

The quantitative analysis is composed of two parts. The first part is devoted to the analysis of the spatial distribution of the ad hoc indicator of land accessibility (real accessibility index, RAI) and two demographic indicators related to the process of aging and foreign presence, namely, the share of the older population (SOP) and the share of the foreign population (SFP). The second part of the paper involves an exploratory spatial data analysis, whose first step consists of a local spatial autocorrelation analysis. The aim is to understand whether or not the geographic distribution of the indicators is clustered, and if so, where local clusters (hot and cold spots) are located. The second step employs geographically weighted regression (GWR) and ordinary least squares (OLS) models to analyze the relationship between the indicators, aiming to understand the overall and local impact of the RAI on SOP and SFP individually.

The results show that the aging process and foreign immigration are associated with the level of accessibility. This exhibits a negative relationship with the proportion of older people, which implies that depopulated and/or aging areas are those in which accessibility is worse. On the contrary, the relationship between accessibility and the proportion of the foreign population is positive, which means that the more accessible areas are also more dynamic and display a greater attractiveness for this population group.

These results hold at the global level, while locally, more different situations arise, underlying something that has been recently addressed by other studies on accessibility and rural depopulation (Panagiotopoulos and Kaliampakos 2024). Although improving accessibility also plays a key role in relation to aging and foreign immigration, spatial inequalities can only be addressed through appropriate locally tailored policies (Iammarino et al. 2019). This is something expected, since in a European context characterized by persistent differences in regional populations (Rees et al. 2012), the relevance of spatially oriented policies is crucial (Muti 2023).

Despite the efforts required to foster social cohesion within the territories of the European Union, some contexts are often left behind in terms of economic growth, and others also appear in demographic decline. Inadequate accessibility, in terms of connecting infrastructures, may be a determining factor in this process.

The rest of the paper is structured as follows. Section 2 outlines the theoretical background and reviews the literature. Section 3 presents the data and methods, and Section 4 introduces the results. Section 5 contains the discussion and, finally, Section 6 holds our preliminary conclusions.

Appendix A contains several maps of Italy's administrative divisions to help readers better understand the analysis. There is also a map of the urban–rural divide based on the degree of urbanization (OECD et al. 2021).

2. Theoretical Background and Literature Review

In this section, we provide an overview of the concept of accessibility and the existing approaches for its measurement (Section 2.1), the relationships between accessibility, population change, and economic growth (Section 2.2), and finally, the role of spatial heterogeneity in influencing the connections between accessibility and population dynamics (Section 2.3).

2.1. Accessibility: Concept and Measures

The theoretical background on accessibility identifies two primary components, namely the transport network and land use (Geurs and van Wee 2004; Stepniak and Rosik 2018).

The transport network refers to the concepts of friction or facilitation in mobility, encompassing the availability of services provided by the transport system, which includes the ease or difficulty of journeying between two points. The transport network is therefore directly related to the provision and characteristics of the local mobility infrastructure (Geurs and Ritsema van Eck 2001). It may be viewed as a direct reflection of a territory's degree of accessibility, which is intrinsically linked to the presence or absence of connecting infrastructures (Handy and Niemeier 1997), being closely associated with factors such as the physical development of infrastructure, deterrence or impedance (Moya-Gómez et al. 2018), and transportation policy, such road tolls (Solé-Ribalta et al. 2018).

The component of land use concerns the spatial distribution of accessibility. It describes the spatial attributes of supply and demand for connecting infrastructures, the spatial characterization of related activities, and their relationships (Geurs and Ritsema van Eck 2001). It also includes the role of accessible destinations from a spatial perspective (Vickerman 1974; Caschili et al. 2015). The spatial distribution of population change, including some demographic phenomena, such as aging and foreign presence, can be considered within the land-use component related to the accessibility issue. Indeed, a more complex and holistic definition of accessibility requires further elements, such as its role in residential land-use patterns (Hansen 1959), the ease with which a specific destination can be reached (Dalvi and Martin 1976), and the benefits derived from the transportation network. Accessibility is a potential driver of opportunities, particularly in its association with the efficiency of the transport system, which is crucial to reducing the spatial frictions associated with movement (De Montis and Reggiani 2012; Patuelli et al. 2007).

The definition of accessibility is, therefore, based on the assumption that a territory's appeal (relating to various aspects of the land-use component) increases in step with a reduction in physical distance, travel time, and the cost associated with the transport network (Stepniak and Rosik 2018). This might imply that regions with more efficient access to various locations should be more attractive and competitive, including in demographic terms, than isolated areas (Benassi et al. 2021b).

Empirically, the measurement of accessibility poses challenges. The approach commonly used involves evaluating the local transport system. In this vein, three categories are typically assessed, including (1) isochrones, based on the number of destinations according to travel time/physical distance/costs from a given starting point; (2) gravity-based models, based on a penalty assigned to more isolated destinations; and (3) individual-level models, grounded in individual utility (Handy and Niemeier 1997).

A more recent classification of accessibility measures suggests a different point of view depending on the object of observation and involves the following: (1) infrastructure-based measures, based on the observed performance of the infrastructure; (2) activity-based measures, based on the number of activities in which, even potentially, individuals may participate given time and space constraints; (3) utility-based measures, based on the utility people derive from reaching specific locations; and (4) individual-based measures, related to land-use and transportation systems allowing people to travel (Geurs and Ritsema van Eck 2001; Geurs and van Wee 2004; Karou and Hull 2014).

In this paper, as detailed in Section 3 Methodology, to which we refer for a more analytical view, we used a revised version of the accessibility indicator released by the Italian National Institute of Statistics (ISTAT) in December 2023.

2.2. On the Role of Accessibility in Economic and Demographic Change

Although numerous nuances exist regarding the concept of accessibility, its critical role in shaping the overall dynamics of local development is widely recognized. Two regional economic theories clearly describe the impact that varying degrees of accessibility have on development: growth pole theory and location theory.

Growth pole theory revolves around the concept of a "growth fulcrum", which is the existence of a center capable of exerting attraction upon surrounding areas. The core concept is that a specific location, typically urban, interacts with its surrounding areas through economies of scale and agglomeration, rebalancing development levels between these areas (Darwent 1969).

In turn, location theory asserts that the decisions firms and individuals make on their deployment are influenced by choices of cost minimization and demand maximization. The transport network, therefore, serves as a facilitator of relationships and flows between central hubs and their surrounding areas; it may, however, become a barrier when the transport infrastructure is deficient (Thompson and Bawden 1992; Voss and Chi 2006).

As changes in accessibility could lead to changes in local economic conditions (Berechman and Paaswell 2001; Ozbay et al. 2006), accessibility also influences population change

(Alamá-Sabater et al. 2019). According to a demographic approach, population change involves the interplay between the two components of natural change (i.e., births and deaths) and migration. The increasing decline in births is leading many territories, particularly those in rural areas, toward a continuous and inevitable process of depopulation (Alamá-Sabater et al. 2019; Melo et al. 2022; Reynaud et al. 2020). From a theoretical perspective, the impact of accessibility on population change has been explored through various models, including the general equilibrium model of household location choices (Roback 1982). In this model, transport costs are central to individual location decisions, as some households generally prefer locations with affordable property and easy access to urban amenities.

The role of the infrastructure system in population variations can also be understood through the lens of neo-classical growth theory. This theory posits that the combination of land (rural–suburban), capital (infrastructure systems), and labor (wages) (as inputs into production function) predicts that, as the transport network expands, the economic and social centrality of a region increases, potentially leading to (positive) population changes. Similarly, the facilitator role of the infrastructure system is a crucial aspect in the central place theory, whereby transport networks serve as vectors for relationships and flows between individuals across different locations, typically facilitating movement between a central hub and its surrounding regions (Thompson and Bawden 1992).

A large body of the literature has traditionally explored the factors, such as the presence of large cities, regional migration, economic growth, and sundry facets of quality of life and well-being, as elements that influence people's inclination to settle in a particular location (Glaeser et al. 1995; Graves 1983; Chi and Marcouiller 2009). Most of this research reports that greater accessibility, particularly in terms of transportation infrastructures, positively influences an area's economic growth by generating positive externalities for local firms (Berechman and Paaswell 2001), increasing employment in the region (Ozbay et al. 2006), and reducing commuting times, thereby enhancing the work–life balance (Van den Heuvel et al. 2014). Following this line, from a macro approach, many studies have investigated the correlation between the degrees of accessibility and economic indicators, such as the marginal effect on the price of commodities or GDP (Gutiérrez et al. 2010; Karou and Hull 2014). These studies underscore the overall positive effect that an increase in accessibility may have on a region's macroeconomic growth.

Recently, some studies have incorporated the concept of spatial dependence as an additional factor contributing to population change (Lundberg 2006; Delfmann 2014; Costa da Silva Firmino et al. 2017).

Chi (2010) has used an integrated spatial regression approach to investigate the impact of highway expansion on the population in Wisconsin, finding a difference among rural, urban, and suburban areas. Highway expansion triggers population flows, especially in suburban areas where the direct effect on demography is supported by the ease of commuting to urban areas and the lower cost of housing.

Melo et al. (2022) have explored the role of road accessibility in population changes in Portugal, finding that the decline in population is not simply explained by changes in accessibility: depopulation is explained mainly by demographic and economic factors, such as an uncompetitive job market. This study finds that enhancing accessibility seems to have the potential to reverse the progressive decline of rural territories by, for instance, offsetting the increasing number of individuals aged over 65 or the scarcity of those with higher education.

Focusing on aging as a pivotal demographic process in depopulation, Alamá-Sabater et al. (2019) have used an exploratory spatial data analysis to explore the issue in the hinterland of the Spanish region of Valencia. They consider specific territorial factors, such as the degree of accessibility, public infrastructures, and economic prosperity, while shedding light on the role played by the aging rate in the transition towards depopulation. Their study reveals that the lack of accessibility to rural areas is associated with a higher risk of population loss. Interestingly, the authors also find that the concept of rural depopulation cannot be understood solely at the municipal level but requires an understanding of the spatial interdependencies between a territory and its surroundings.

In sum, while the seminal literature on the relationship between accessibility and population change generally reports linear results, some local-level studies find significant heterogeneity due to an area's idiosyncrasies, which include local growth characteristics, environmental and natural resources, and land use and related development (Cardille et al. 2001), which may vary spatially across different territories (Partridge et al. 2008).

Closely linked to potential population change, especially at the local level, is the presence of a migrant population (Bagavos 2022), as new arrivals tend to settle within specific ethnic enclaves to enjoy the support of other non-natives.

Numerous studies have explored the settlement patterns of immigrants in both the United States and Europe (Hiebert 2000; Lo et al. 2011). Some of these investigations have revealed robust spatial correlations between migrant settlement trends and suburbanization (Kneebone and Garr 2010; Ehrenhalt 2012; Farrell 2016). Location decisions are often influenced by socioeconomic factors and the availability of affordable housing (Allen et al. 2021), with a strong spatial correlation between settlement and the concentration of poverty in urban areas (Kazemipur and Halli 2000; Burnley 2002).

Only a limited body of research has examined the relationship between transport accessibility and the presence of migrants. Existing research has linked restricted accessibility to greater difficulties in accessing supermarkets, schools, language classes, and healthcare services (Bose 2014). These geographic obstacles compel migrants to settle within ethnic groups, significantly limiting their potential for long-term integration and assimilation (Wang 2008), with deficient transport constituting a reason for accessibility-related social exclusion (Lucas 2012). Allen et al. (2021) have used spatial filters in regression models to explore the tendency among migrants to settle in specific areas based on their accessibility. The authors consider the influence carpools for commuting have on the choice to settle in specific areas, particularly suburban and rural ones, regardless of the local socio-economic characteristics. The transport system plays a key role as a vector of social relations and a facilitator of integration.

The impact of territorial accessibility on the population (in terms of aging and foreign presence) and the possible existence of local heterogeneities is of particular relevance in this study, especially in relation to the specific geo-demographic characteristics of Italy, which, as described in the introduction of this paper, substantially define its socio-economic and demographic profile.

2.3. On the Spatial Heterogeneity in the Accessibility–Population Change Nexus

In addition to the widely acknowledged benefits that a good transport network has on population growth, numerous empirical studies at a more granular level have reported different findings, due primarily to the geographic heterogeneity of different areas (Chi 2010). The overall effect tends to reflect a collective impact, obviating the local nuances of this general effect, and providing potentially misleading information about local dynamics. The presence of spatial variations in impact is generally attributed to two main factors. First, variations in the effects throughout the various stages of developing the transport infrastructure, with differential impacts during the pre-construction and post-construction phases (Bhatta and Drennan 2003). Second, some studies attribute these variations to the presence of deep spatial and geographic heterogeneities in different areas (Partridge et al. 2008). Given the scope of this study, we focus on the moderating role of the socio-economic characteristics of territories in the accessibility–population change relationship.

Urban, suburban, and rural areas may be significantly different in their growth mechanisms. The literature identifies distinct patterns of depopulation and population loss in urban and local contexts. There is a mutual relationship between rural and urban areas, where the dynamics of one tend to influence the other in an osmotic manner. However, the awareness of differentiated and often non-generalizable results has led numerous scholars to focus exclusively on population change in rural or urban contexts, neglecting the pivotal role of local interaction and contagion dynamics (Wolff and Wiechmann 2018).

Returning to the impact that transport infrastructures have on population change, differentiated effects at the rural/suburban and rural levels have been identified (Chi 2012). In rural areas, transport networks tend to favor population growth. Improving transport networks may attract individuals from more polluted urban areas (Isserman et al. 2009). This improvement may also attract firms, leading to job creation and economic growth (Graham and Gibbons 2019). This, in turn, stimulates local population change (Rasker et al. 2009). Furthermore, by reducing the travel time to surrounding areas, transport networks expose rural areas to larger markets and create more opportunities.

Furthermore, in the international literature on rural depopulation, a central topic is the provision of essential facilities and services necessary for residents in rural areas to maintain an adequate quality of life (Farmer et al. 2012; Neumeier 2016). In this vein, public spatial planning can play a crucial role in addressing issues related to the facility decline (Christiaanse 2020). Following this reasoning, some countries (i.e., The Netherlands) have introduced policies that allocate funds to rural areas to tackle the challenges associated with three key areas, namely housing, economic competitiveness, and the availability of facilities and services (Haartsen and Venhorst 2010).

In suburban areas, improvement in accessibility may have a variety of significant effects. First, better transport networks may increase property values in suburban areas, making them more attractive for residential and commercial uses (Debrezion et al. 2007), positively influencing population growth as people move away from congested urban centers in search of better living conditions (Chi 2012). Second, the progressive strengthening of transport infrastructures contributes to urban expansion, gradually decongesting city centers (Ewing 1997), thus reducing travel time and emissions. Furthermore, it may have certain social and community benefits. Better accessibility in suburban areas may foster social integration by facilitating easier mobility between various locations (Graham and Gibbons 2019). Additionally, it provides suburban residents with better access to essential services, such as healthcare, education, and retail (Litman 2015).

Finally, the relationship between improved accessibility and population change is more complex in urban areas than in surrounding ones. In general, advancements in transportation infrastructure typically follow a U-shaped pattern. Initially, an improved transport network may yield positive effects, fostering connectivity and accessibility to remote neighborhoods and leading to demographic growth. However, beyond a given threshold, additional improvements may have adverse effects, such as environmental pollution, noise, and declining property values near major infrastructures (Chi and Parisi 2011).

Although primarily exploratory in nature, the empirical analysis, which is conducted on a local scale, will allow us to assess how the impact of accessibility on aging and foreign presence may vary across different territorial contexts.

3. Methodology

In this section, the data used to calculate the three indicators in the empirical analysis—RAI, SOP, and SFP—will first be described, along with a brief description of each (Section 3.1). Then, the local spatial autocorrelation analysis is conducted, and the indicator chosen for this purpose will be presented (Section 3.2). Finally, the last part will cover the global (OLS) and local (GWR) regression models used (Section 3.3).

Before proceeding, it seems useful to mention that the analysis was conducted using three distinct software tools, namely GeoDa (version 1.22) and MGWR 2.2 (Oshan et al. 2019) for the spatial econometric analysis and QGIS (version 3.36.2) for the construction of thematic maps.

3.1. Data and Indicators

The data used in this study have been provided by the Italian National Institute of Statistics (ISTAT) and consist of two different datasets. The first one corresponds to the resident population in each Italian municipality in 2021 broken down by age and nationality (i.e., country of citizenship).

The second one is part of a 2021 municipal-level study on accessibility to infrastructure nodes involving four transport networks, namely road, railway, maritime, and air (ISTAT 2023).

The demographic indicators are the share of the older population (SOP), defined as the ratio of people aged 65 and over to the total population per 100 residents, and the share of the foreign population (SFP), defined as the ratio of foreign residents to the total population, also per 100 residents.

In terms of accessibility, we have focused on the motorway and rail transport networks (i.e., land accessibility). ISTAT has recently proposed two distinct accessibility measures for each municipality, namely the distance (in minutes) to the nearest infrastructure, defined as "cost to closest", and the opportunities provided by nearby infrastructures, as determined by the gravitational model. The first measure treats all infrastructures equally in terms of services and options, representing a form of "potential" land accessibility. The second measure considers the actual services and options provided by these infrastructures, influencing an individual's willingness to access them. This latter measure is a more accurate gauge of "real" accessibility to transport infrastructures. In order to have an overall reference for land infrastructure, the indicators published by ISTAT for each municipality for rail and road "real" accessibility were first standardized and then an arithmetic mean was calculated for each municipality. Finally, a min–max approach was used to recalculate this value. This index is defined as the real accessibility index (RAI).

The empirical analysis has been conducted at the municipal level, encompassing slightly more than 7900 statistical units. The geographic data (shape files) for these municipalities have also been provided by ISTAT.

All the data used are available on the official ISTAT website.

3.2. Local Spatial Analysis

The empirical research involves an exploratory spatial data analysis that has been increasingly used in population-based studies in recent years (Matthews and Parker 2013). In the first part of the paper, the spatial distribution of the indicators (RAI, SOP, and SFP) is investigated by using thematic maps and the local univariate G_i^* index of Getis and Ord (Getis and Ord 1992; Ord and Getis 1995).

This index identifies the areas in which comparatively high (or low) values of each indicator are near each other, creating local spatial clusters. Clusters of comparatively high values represent hot spots, which are spatially contiguous areas in which the value of the observed indicator is high. By contrast, clusters of comparatively low values are defined as cold spots and depict contiguous areas in which the value of the observed indicators is low. Finally, there is a third cluster of areas in which no spatial structure is observed, with the distribution following a random pattern.

The attribution of spatial weights involves a first-order queen-based contiguity matrix, whereby two territorial units (i.e., municipalities) are considered adjacent if they share a boundary or geographic limit. The variables in all the spatial autocorrelation analyses are expressed in a standardized form, whereby their means are zero and their variance one. In addition, the spatial weights are standardized in rows. The hypothesis of the existence of a condition of univariate and bivariate spatial clustering has been tested at a 5% level of statistical significance (p-value ≤ 0.05).

3.3. Regression Analysis

The second part of the empirical research involves a regression analysis to understand the net effect of the RAI on SOP and SFP individually. A local regression approach using a geographically weighted regression model (Fotheringham et al. 2003) has, therefore, been adopted using ordinary least square (OLS) models as a benchmark.

The GWR model has been estimated using a golden section algorithm (to identify the best bandwidth, i.e., the number of municipalities for estimating the different local models) and a spatial kernel of the adaptive bi-square type for the process of model-weighting in the calibration phase. This type of kernel is appropriate when the distribution of statistical units (centroid) is not uniform (as in our case; see Figure 1). We have used the corrected Akaike information criterion (AICc) for optimization purposes.

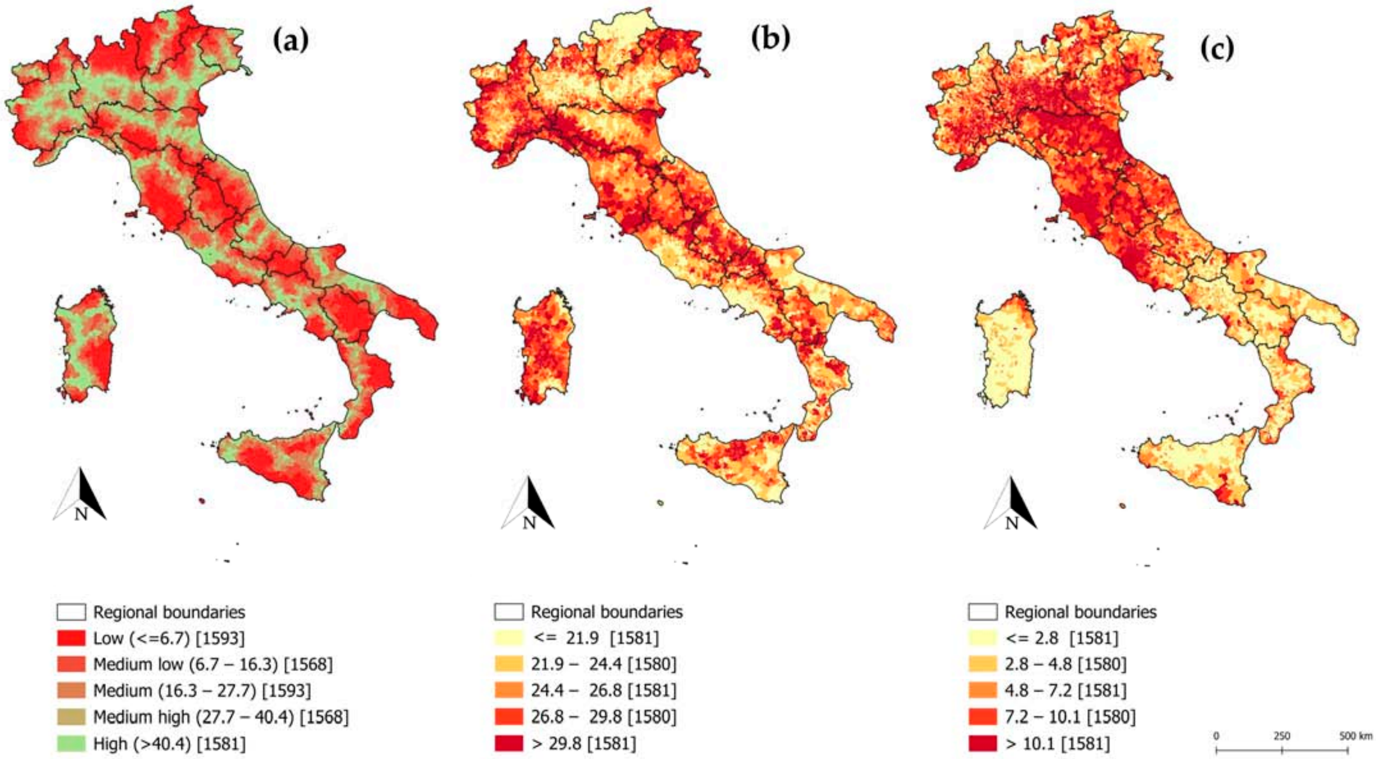

Figure 1. Quantile maps of the RAI (**a**), SOP (**b**), and SFP (**c**). Italian municipalities, 2021.

The regression analysis first estimates an OLS (global and non-spatial) model. This model and its results serve as a benchmark in evaluating the performance of the GWR model. The evaluation of the two models has been conducted according to the standard parameters relating to their explanatory capacity (R^2) and overall performance (AIC). In addition, we evaluated the spatial stationarity in the residuals of both models by conducting a Moran's *I* test for residual spatial autocorrelation (Moran 1948). For this aim, as in the local spatial analysis (Section 3.2), a first-order queen-based contiguity matrix was used.

Prior to the regression analysis, the variables (SOP, SFP, and RAI) have been standardized into a Z distribution, whereby each one of them has a zero mean and a standard deviation of one.

4. Results

This section presents the results of the spatial analysis of the geographic distribution of the selected indicators (Section 4.1), followed by the results of the GWR models, using OLS as a benchmark (Section 4.2)[1].

4.1. Geographic Distribution and Local Spatial Autocorrelation Analysis

The geographic distribution of the three elementary indicators (Figure 1) reveals a complex mosaic in which several spatial patterns can still be discerned. Italy is characterized by a marked heterogeneity in geo-demographic terms, being a foundational characteristic and a distinctive feature (Billari and Tomassini 2021).

Concerning the spatial distribution of the RAI, Figure 1a shows that high values tend to concentrate more near large Italian cities (e.g., Milan, Rome, Naples, Turin, and Florence).

Notably, there is a gradual decline in accessibility levels as one moves away from these urban centers towards progressively more remote ones. This trend is particularly evident when examining the hinterland, which includes municipalities located close to the Apennines and in the foothills of the Alps.

Regarding the spatial distribution of the SOP (Figure 1b), major Italian cities have a less aged population, probably due to the employment opportunities that attract a younger demographic both from other parts of Italy (internal migration) and from abroad (international migration). Figure 1c reveals a clear north–south divide regarding the foreign population. The north accounts for higher values of the RAI, particularly near major cities and areas with an industrial presence. These are Italy's more dynamic areas from a demographic and economic perspective (Buonomo et al. 2024). Although some spatial patterns emerge, such as the urban–rural dichotomy and the north–south divide, the level of heterogeneity remains quite high, due also to the small geographical scale adopted.

Analysis of the local spatial autocorrelation index of Getis and Ord (Figure 2) can help highlight the hot and cold spots in the distributions of the three indicators, thereby making them easier to interpret.

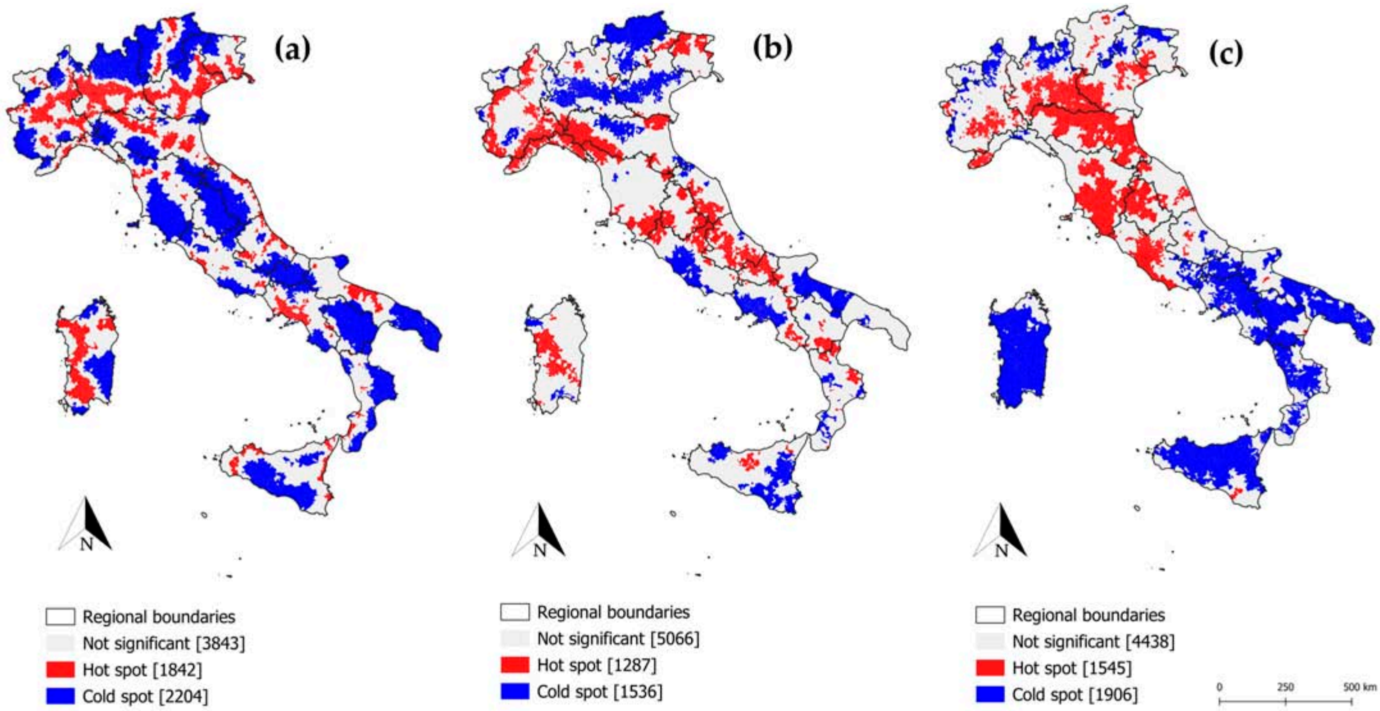

Figure 2. Hot spot and cold spot based on G_i^*. RAI (**a**), SOP (**b**), and SFP (**c**).

The spatial patterns that emerge are quite different from one indicator to another. In the case of the RAI, it is noticeable that inland areas and some coastal ones, particularly located in the southern quadrant and on Sicily and Sardinia, are characterized by clusters of municipalities with low accessibility levels (cold spots). However, this same situation applies to many areas in both northern and central Italy. It is no coincidence that the cold spots outnumber the hot ones (2204 versus 1842). This latter group, however, has a more concentrated geographic distribution in the north, especially in highly urbanized areas. The geographical distribution of Hot Spots in northern Italy, unlike in the south and center, surpasses administrative boundaries, forming supra-regional clusters.

The SOP indicator also shows a higher number of cold spots than hot ones and, compared to RAI its territorial distribution, has fewer clusters (there are 5066 municipalities where the distribution is not spatially dependent). The cold spots mainly affect some areas in the north, including Trentino Alto Adige, a region known for its relatively high birthrate compared to other parts of Italy, as well as much of the Po Valley, and generally the conurbations around large cities, particularly the 14 metropolitan cities (see cartographic Appendix A for a better representation of administrative geographies). Conversely, the hot spots seem to prevail in the hinterland, especially in the center–south. In the north, a vast and compact area of this type of municipal cluster corresponds to parts of Emilia Romagna, the northwestern quadrant, and practically all of Liguria, one of Italy's most aged and demographically fragile regions.

Finally, the SFP indicator is geographically very clear. Italy is essentially split in two. All the hot spots are in the center–north, particularly in urban areas, albeit not exclusively so. Clusters also affect inland and more peripheral areas. The south, and particularly Sicily and Sardinia, contain the bulk of the cold spots.

4.2. Regression Models

The regression analysis should be considered an exploratory approach here, with the aim being to assess the local (and overall) impact of the RAI on the SOP and SFP, without making any causal or explanatory claim.

We have, therefore, estimated two models. SOP is the dependent variable in model 1, and RAI is the independent one. SFP is the dependent variable in model 2, and RAI is, again, the independent one. We first present the results of the overall OLS non-spatial regression model (Table 1), which acts as a benchmark for the local regression model (GWR) at the core of this analysis.

Table 1. OLS model.

Model	Beta		*p*-Value
model 1 (SOP = f RAI)	−0.326		0.000
model 2 (SFP = f RAI)	0.179		0.000
R^2 model 1		0.106	
R^2 model 2		0.032	
AIC model 1		21,542.626	
AIC model 2		22,173.894	
Moran's *I* model 1 residuals		0.578	
Moran's *I* model 2 residuals		0.578	

Overall, there is an inverse relationship between RAI and SOP (−0.326 with a *p*-value of 0.000). This means that accessibility reduces the SOP and, in a certain way, affects the aging process in the different local contexts. As expected, there is a direct relationship between the RAI and SFP (0.179 with *p*-value 0.000). This means that accessibility acts as a magnet for the foreign migrant population, whereby greater accessibility, typically in urban areas (Figure 1, panel a), also increases the SFP. The explanatory capacity of both models is limited, even though the RAI alone in model 1 explains around 11% of the variance in the dependent variable. It is important to remember, nonetheless, that this analysis seeks solely to explore the relationship at the local level between the selected variables.

The GWR models (Table 2) perform better than the OLS models, with a higher R^2 and a lower AIC. However, it is important to note that this better performance is likely largely attributable to the intercept. Moreover, the residual correlation in the GWR models is very close to zero, whereas in the OLS models, the residual correlation is quite high (see Tables 1 and 2).

The local coefficient's summary statistics show that the local parameters (local beta) in both models are characterized by geographic variability.

One of the main strengths of local models is the ability to map local parameters (Matthews and Yang 2012). Figures 3 and 4 show the geographic distribution of the local coefficients. When mapping the local coefficients, we have assumed two t-values to protect against potential false positives resulting from the small bandwidth at which the local regressions are estimated (Yu et al. 2020).

Table 2. GWR model [1].

Model	Mean	Standard Deviation
model 1 (SOP = f RAI)	−0.567	2.840
R^2	0.677	
AIC	15,030.774	
Moran's *I* model 1 residuals	0.036	
model 2 (SFP = f RAI)	0.288	1.629
R^2	0.608	
AIC	16,568.788	
Moran's *I* model 2 residuals	0.036	

[1] Spatial kernel: adaptive bisquare; criterion for optimal bandwidth: AICc; bandwidth used: 45.

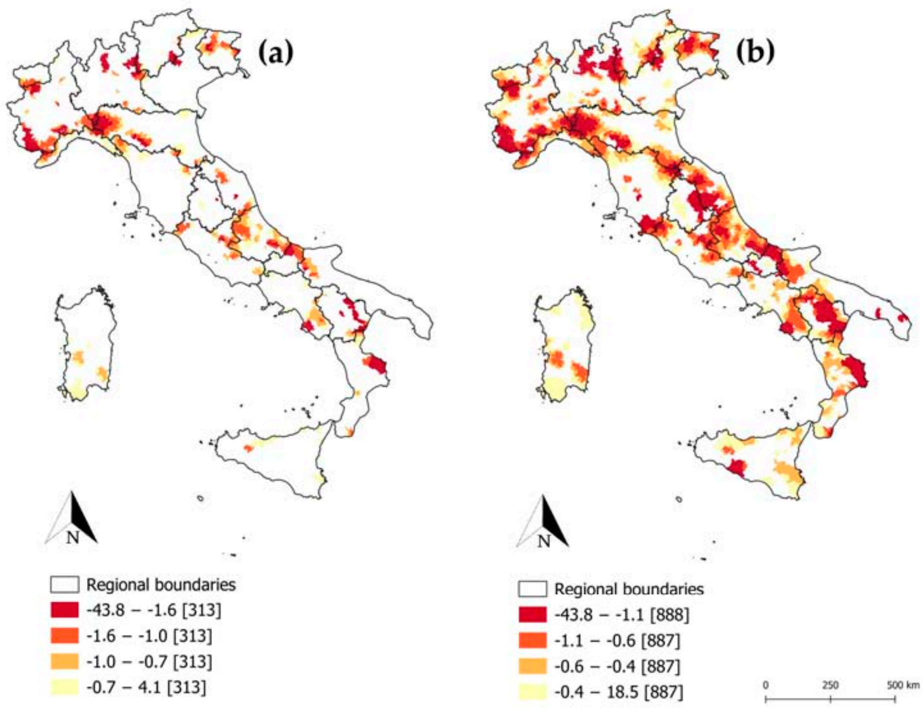

Figure 3. Model 1 (SOP = f RAI). Local beta: (**a**) (t ± 3.83), (**b**) (t ± 1.96).

An analysis of the geographies and intensity of the signs of the local coefficients allows us to identify certain concrete evidence (Figure 3). The most significant negative effects are in the hinterland where, as the indicator's thematic maps show, aging is more intense and greater accessibility significantly reduces it. The effect is mildly negative (and in some cases positive) in coastal areas, where high accessibility increases aging. These are areas with extensive amenities, such as the northwestern part of Sardinia, coastal parts of Sicily, Liguria, and rural areas in Tuscany. These areas have always been affected by retirement migration, including foreign arrivals. In this case, greater accessibility combined with high environmental and territorial capital increases aging. Although generally highly accessible, large cities are not statistically significant. This means that accessibility in urban contexts is not a driver of aging, which is evidently influenced more by other factors.

In the case of the geographies of the local betas of model 2 (Figure 4), the effect is in most of the cases positive, so a higher real accessibility basically corresponds to a higher SFP.

However, what emerges seems interesting and can be summarized as follows.

Accessibility plays a role in the SFP in a heterogeneous way throughout the territory in terms of signs and intensities at the local level. In some cities in the north, the relationship between higher accessibility and a higher SFP is confirmed. In the center and south, this relationship is less apparent. In southern Tuscany, finally, the relationship is negative (or in some cases mildly positive); these are areas where greater accessibility corresponds to a lower SFP (in relative terms). This includes the southern province of Livorno and part of Grosseto, which are not particularly dynamic areas from a demographic point of view, and certainly not especially attractive to foreign arrivals. The same relationship is observed on the southern tip of coastal Lazio and the Ragusa area of eastern Sicily. The situation in the south is fragmented and not easy to interpret, suggesting that there is no link between greater real accessibility and a higher SFP. This is because foreign arrivals in the south prefer locations that are not strictly urban (where lower accessibility is assumed). It should also be considered that the SFP in the south is relatively small (accounting for just under 900,000 in the entire region compared to five million nationwide, of whom 25% are in the center).

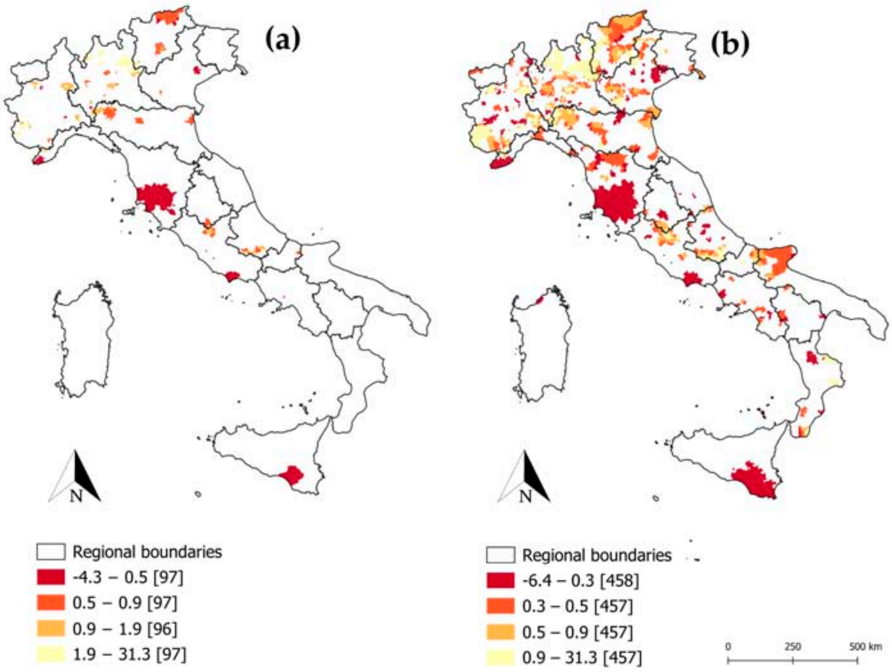

Figure 4. Model 2 (SFP = f RAI). Local beta: (**a**) (t ± 3.83), (**b**) (t ± 1.96).

5. Discussions

Italy is a geographically complex country, characterized by an aging population, persistently low fertility (Billari and Tomassini 2021), and deep territorial divides (Zambon et al. 2020; Viesti 2021). The native population is shrinking, and future demographic forecasts indicate that the population is set to fall sharply, from 59.2 million on 1 January 2021, to 57.9 million in 2030, 54.2 million in 2050, and 47.7 million by 2070.

This decline will not affect the entire territory uniformly, but it is likely to impact those areas that have already been experiencing demographic contraction, if not outright depopulation, for many years (Reynaud et al. 2020).

At the same time, the foreign population is growing, primarily due to the positive net immigration recorded in recent times. This migrant population will significantly impact Italian society and its various territorial contexts in more ways than purely demographics (Termote 2005).

These processes conceal significant local heterogeneity, which although it has already been investigated in various studies, it does not appear, to the best of our knowledge, to have been examined in terms of transport accessibility.

This is quite surprising if we bear in mind that accessibility to territories can play an important role in configuring population settlement patterns by socio-demographic characteristics, such as age or nationality. In this sense, the level of accessibility can make attractive or repulsive a territorial context, influencing its demography. Indeed, demographic dynamics, which can lead to depopulation in some rural areas or to the isolation of subpopulations, such as the elderly one, can depend on the conditions of access to these contexts. The lack of adequate land accessibility often forces rural populations to travel long distances to meet basic needs and access services (Van den Heuvel et al. 2014), and in general, low accessibility is a factor of depopulation and demographic weakness (Panagiotopoulos and Kaliampakos 2024; Melo et al. 2022; Rodríguez-Rodríguez and Larrubia Vargas 2022; Alamá-Sabater et al. 2019, 2021; Sánchez-Mateos and Pulpón 2021), albeit with a certain degree of local variability (Benassi et al. 2021b).

This issue is particularly relevant given the profound differentials in logistical infrastructure (and more) that differentiate the Italian territory—especially at the intra-regional level—and have been addressed by active intervention policies, with the best known and significant being the Strategy for Inner Areas (Barca 2009).

This contribution, which expands upon a preliminary study (Carella et al. 2024), has used local spatial analysis tools to (i) explore the spatial dimension of accessibility (RAI) and two demographic indicators (the share of older population, SOP, and the share of foreign population, SFP) and to (ii) estimate the (global and local) impact of accessibility (RAI) to the other two demographic indicators (SOP and SFP).

The results are naturally partial and improvable, as the study represents an initial, predominantly exploratory, attempt. However, certain emerging elements seem useful for better guiding future studies and for making a few initial considerations.

The first result is that all three indicators are not space independent. On the contrary, their geographical distribution outlines rather clear spatial patterns that only partly reflect the well-known north–south dichotomy. Ignoring this dimension could, therefore, lead to the implementation of ineffective intervention policies. From this perspective, the urgency of thinking locally in terms of quantitative analyses that are useful for territorial planning and local societies becomes quite clear (Fotheringham and Sachdeva 2022)

The accessibility of territories, and, thus, their level of infrastructure and connectivity, has a negative impact on the SOP and a positive one on the SFP. This indicates that better-connected territories are more attractive, less aged, and, one assumes, demographically less static. Greater accessibility is necessary to not only attract people but also to foster territorial redistribution according to a regional demographic development scheme that should aim toward polycentric models (Benassi et al. 2024).

An arrangement of medium-sized cities, well connected to each other, promotes balanced territorial development and defuses processes of spatial polarization in which some areas gain—typically those with high accessibility—while others that are geographically isolated and aged lose out (Cardoso 2022).

In the long run, demographic and territorial systems of this nature, based on competitive rather than cooperative/redistributive logics, are destined to lose out overall, concerning both urban populations—compressed into spaces defined by low quality of life and significant environmental impacts—and those living in rural or non-urban contexts that seem destined to disappear, except for rare cases, where the lack of essential services and dynamic labor markets leads to significant demographic contraction and depopulation (Benassi et al. 2021b).

Even within a framework of high local heterogeneity, investing in accessibility seems capable of "breaking" this polarized dynamic, reconnecting places, and, thus, promoting the connection of populations. Naturally, it is necessary to consider smart and environmentally friendly forms of mobility.

It is, therefore, crucial to develop policies that both maximize the area's connectivity by enhancing infrastructure and improving physical accessibility, also taking into account increasing the attractiveness by strengthening its economic competitiveness.

In this direction, a combination of national/regional and local policy interventions should be implemented. These could include the improvement of public transportation networks, subsidized public transportation programs, or rural connectivity initiatives able to improve accessibility in rural or less populated areas. In terms of enhancing the competitiveness of these areas, public policy initiatives could include measures such as income tax reductions, offering housing at symbolic prices to individuals who choose to settle permanently in rural areas or regions experiencing progressive population aging (as already implemented in at-risk areas of Sicily), or implementing labor market incentive policies at the macro-regional level (i.e., promoting female or youth entrepreneurship).

The combination of these strategies (at the macro and micro-local level) could make these areas more appealing to migrants from other parts of Italy and abroad, thereby potentially mitigating the effects of population aging (Benassi et al. 2024)

The findings of this study can act as a valuable guide, emphasizing the significance of adopting a local approach to planning public efforts. Additionally, the study highlights the importance of considering territory accessibility (alongside economic and social factors) when formulating both macro and micro policy actions.

However, it is important to recognize that a local approach may lead to results that are not generalizable across different local areas, but it is specific to the reference area. If this method can be time-consuming and costly, applying a macro global model risks leading to misleading results. The social cohesion of the various local contexts, as has always been emphasized even at the European level (European Commission 1999), depends on connected and interacting territorial systems capable of attracting population (domestically but also and especially from abroad) and promoting territorial redistribution. Investing in accessibility may well marshal this necessary change, even if only partially so.

6. Conclusions

The aging of the population and foreign presence (due to international migration) are two of the most important demographic processes currently ongoing in Italy (Billari and Tomassini 2021). Usually, the foreign population has been seen as a counteractor of the aging of the population due to its younger age structure and comparatively higher level of fertility, at least in the short and midterm. The paper showed that both processes (aging and foreign presence) are essentially spatial processes characterized by spatial variability and spatial dependence. Moreover, results showed that accessibility can play a pivotal role in such demographic processes, although in a framework of a high level of local heterogeneity. Based on the regression results, we can say that policies aimed at improving the level of accessibility of the local territorial contexts could have positive impacts on local demographic imbalances.

Nevertheless, in line with the results of other contributions (Iammarino et al. 2019; Panagiotopoulos and Kaliampakos 2024), although improving accessibility plays a key role in shaping the territorial distribution and (re)distribution of people and economic activities, spatial inequalities can only be addressed through appropriate locally tailored policies. From this perspective, local approaches confirm their usefulness in supporting place-based policies (Fotheringham and Sachdeva 2022; Benassi et al. 2024).

The study has some limitations and leaves some open doors for further development. In terms of limitations, it should be noted that the analysis is based on three indicators related to a single year and computed based on cross-section data. The analysis conducted is explorative, and the regression models used (OLS and GWR) are very simple in terms of covariates.

Further developments could regard the implementation of a diachronic analysis so that we can refer to the level of accessibility to some measures of population change (such as demographic growth rate or similar). We could enrich the mode-independent variables and, therefore, try to use a local regression model with a varying bandwidth, namely the multiscale geographically weighted regression model (MGWR).

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M.C.; project administration, F.B.; funding acquisition, F.B. All authors have read and agreed to the published version of the manuscript.

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Appendix A

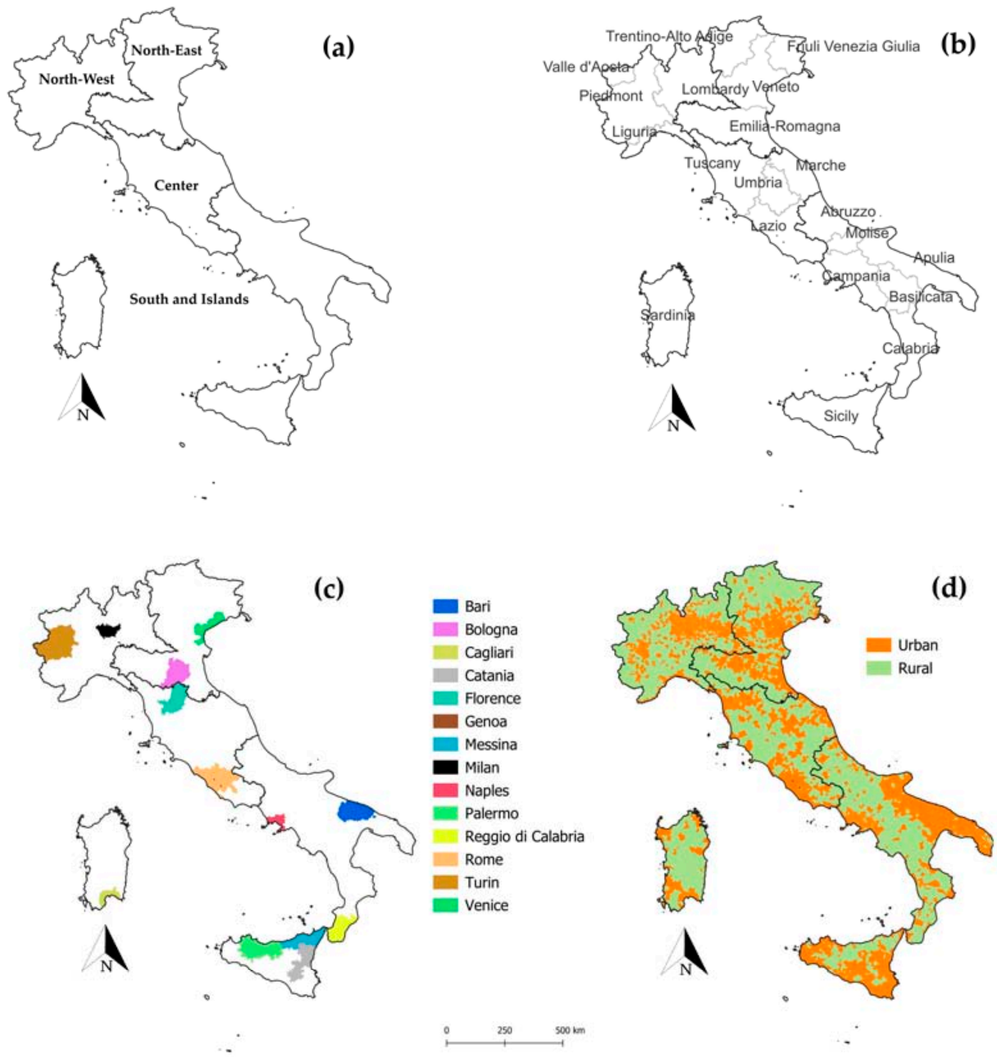

Figure A1. Italian geographies. (**a**) Macro regions; (**b**) Regions; (**c**) Metropolitan cities; (**d**) Urban (Cities, Towns and Suburbs) and Rural Municipalities.

Note

[1] For a better reading and interpretation of the results, it is recommended to consult not only the maps included in this section but also those provided in the Appendix of the contribution, which relate respectively to the Italian macro-regions, Italian regions, Italian metropolitan cities, and Italian municipalities classified as urban and rural according to the degree of urbanization (Degurba) indicator.

References

Alamá-Sabater, Luisa, Vincente Budí, Josè Maria G. Álvarez-Coque, and Norat Roig-Tierno. 2019. Using mixed research approaches to understand rural depopulation. *Economía Agraria y Recursos Naturales-Agricultural and Resource Economics* 19: 99–120.

Alamá-Sabater, Luisa, Vincente Budí, Norat Roig-Tierno, and Josè Maria G. Álvarez-Coque. 2021. Drivers of depopulation and spatial interdependence in a regional context. *Cities* 114: 103217. [CrossRef]

Allen, Jeff, Steven Farber, Stephen Greaves, Geoffrey Clifton, Hao Wu, Somwrita Sarkar, and David M. Levinson. 2021. Immigrant settlement patterns, transit accessibility, and transit use. *Journal of Transport Geography* 96: 103187. [CrossRef]

Annunziata, Alfonso, Francesco Scorza, Simone Corrado, and Beniamino Murgante. 2024. Unveiling intra-rural divides: Investigating decline and prosperity in rural areas. The case study of southern Italy. *European Planning Studies* 32: 1478–505. [CrossRef]

Armenise, Massimo, Federico Benassi, Marica D'Elia, Marianna Mantuano, and Francesca Petrei. 2022. The Exposure Geography of Italian Local Economies to Major Foreign Ones. Evidence from a Multiscale Spatial Experiment Based on Granularity. *Jahrbücher für Nationalökonomie und Statistik—Journal of Economics and Statistics* 242: 87–105. [CrossRef]

Bagavos, Christos. 2022. On the contribution of foreign-born populations to overall population change in Europe. *Demographic Research* 46: 179–216. [CrossRef]

Barca, Fabrizio. 2009. *An Agenda for a Reformed Cohesion Policy. A Place-Based Approach to Meeting EU Challenges and Expectations*. Brussels: European Commission, pp. 1–248.

Barca, Fabrizio. 2019. Place-based policy and politics. *Renewal: A Journal of Social Democracy* 27: 84–95.

Benassi, Federico, Annalisa Busetta, Gerardo Gallo, and Manuela Stranges. 2021a. Diseguaglianze tra territori. In *L'Italia e le Sfide della Demografia*. Edited by Francesco C. Billari and Cecilia Tomassini. Bologna: Il Mulino, Rapporto Sulla Popolazione, pp. 135–62.

Benassi, Federico, Annalisa Busetta, Gerardo Gallo, and Manuela Stranges. 2023. Neighbourhood effects and determinants of population changes in Italy: A spatial perspective. *Vienna Yearbook of Population Research* 23: 311–38. [CrossRef]

Benassi, Federico, Cecilia Tomassini, and Carlo Lallo. 2024. The local regression approach as a tool to improve place-based policies: The case of Molise (Southern Italy). *Spatial Demography* 12: 1–28. [CrossRef]

Benassi, Federico, Marica D'Elia, and Francesca Petrei. 2021b. The "meso" dimension of territorial capital: Evidence from Italy. *Regional Science Policy and Practice* 13: 159–75. [CrossRef]

Berechman, Joseph, and Robert Paaswell. 2001. Accessibility improvements and local employment: An empirical analysis. *Journal of Transportation and Statistics* 4: 49–66.

Bhatta, Saurav Dev, and Matthew P. Drennan. 2003. The economic benefits of public investment in transportation: A review of recent literature. *Journal of Planning Education and Research* 22: 288–96. [CrossRef]

Billari, Francesco C., and Cecilia Tomassini. 2021. *Rapporto sulla Popolazione. L'Italia e le Sfide della Demografia*. Bologna: Il Mulino, pp. 1–262.

Bose, Pablo S. 2014. Refugees in Vermont: Mobility and acculturation in a new immigrant destination. *Journal of Transport Geography* 36: 151–59. [CrossRef]

Buonomo, Alessio, Federico Benassi, Gerardo Gallo, Luca Salvati, and Salvatore Strozza. 2024. In-between centers and suburbs? Increasing differentials in recent demographic dynamics of Italian metropolitan cities. *Genus* 80: 1. [CrossRef]

Burnley, Ian H. 2002. Evolution of Chinese settlement geographies in Sydney, Australia. *Urban Geography* 23: 365–87. [CrossRef]

Campagnucci, Fabiano, and Gabriele Morettini. 2024. Inner areas matter: A place-sensitive approach for the identification of the daily life spaces in the Italian Abruzzo region. *Socio Economic Planning Sciences* 93: 101859. [CrossRef]

Cardille, Jeffrey A., Stephen J Ventura, and Monica G. Turner. 2001. Environmental and social factors influencing wildfires in the Upper Midwest, United States. *Ecological Applications* 11: 111–27. [CrossRef]

Cardoso, Rodrigo Viseu. 2022. City-regional demographic composition and the fortunes of regional second cities. *Urban Geography* 44: 1541–63. [CrossRef]

Carella, Maria, Federico Benassi, Roberta Misuraca, and Massimo Armenise. 2024. Accessibility, population ageing, and foreign presence: A first investigation across local heterogeneities in Italy. In *La Geografía ante los Retos del Desarrollo Local*. Edited by Francisco Javier García-Delgado, María Hernández-Hernández, Antonio Martínez-Puche, Luis Alfonso Hortelano Mínguez and Vicente M. Zapata Hernández. XII Coloquio de Desarrollo Local—I European Meeting on Geography and Local Development. Alicante: University of Alicante, pp. 186–92. [CrossRef]

Caschili, Simone, Andrea De Montis, and Daniele Trogu. 2015. Accessibility and rurality indicators for regional development. *Computers, Environment and Urban Systems* 49: 98–114. [CrossRef]

Chi, Guangqing. 2010. The impacts of highway expansion on population change: An integrated spatial approach. *Rural Sociology* 75: 58–89. [CrossRef]

Chi, Guangqing. 2012. The impacts of transport accessibility on population change across rural, suburban and urban areas: A case study of Wisconsin at sub-county levels. *Urban Studies* 49: 2711–31. [CrossRef]

Chi, Guangqing, and David W. Marcouiller. 2009. Rethinking the Migration Effects of Natural Amenities: Part II. *Canadian Journal of Regional Science* 32: 349–59.

Chi, Guangqing, and Domenico Parisi. 2011. Highway expansion effects on urban racial redistribution in the post—Civil rights period. *Public Works Management and Policy* 16: 40–58.

Chiocchini, Raffaela, and Sandro Cruciani. 2009. L'accessibilità ai nodi infrastrutturali: Un'applicazione sperimentale attraverso l'uso di strumenti GIS. In *Indicatori e Modelli Statistici per la Valutazione degli Squilibri Territoriali*. Edited by Giorgio Alleva and Piero Demetrio Falorsi. Milano: Franco Angeli, pp. 309–42.

Christiaanse, Suzan. 2020. Rural facility decline: A longitudinal accessibility analysis questioning the focus of Dutch depopulation-policy. *Applied Geography* 121: 102251. [CrossRef]

Costa da Silva Firmino, Diego, J. Paul Elhorst, and Raul da Mota Silveira Neto. 2017. Urban and rural population growth in a spatial panel of municipalities. *Regional Studies* 51: 894–908. [CrossRef]

Dalvi, M. Quasim, and Keith M. Martin. 1976. The measurement of accessibility: Some preliminary results. *Transportation* 5: 17–42. [CrossRef]

Darwent, David F. 1969. Growth poles and growth centers in regional planning—A review. *Environment and Planning A* 1: 5–31. [CrossRef]

De Montis, Andrea, and Aura Reggiani. 2012. JTG special section on accessibility and socio-economic activities: Methodological and empirical aspects. *Journal of Transport Geography* 25: 95–97. [CrossRef]

Debrezion, Ghebreegziabiher, Eric Pels, and Piet Rietveld. 2007. The impact of railway stations on residential and commercial property value: A meta-analysis. *The Journal of Real Estate Finance and Economics* 35: 161–80. [CrossRef]

Delfmann, Heike. 2014. Why start a business in a declining rural area with an ageing society? A UK–NL case study. Presented at the 54th Congress of the European Regional Science Association: "Regional Development and Globalisation: Best Practices", St. Petersburg, Russia, August 26–29.

Ehrenhalt, Alan. 2012. The Public Service Heritage. In *Human Resource Management in Public Service: Paradoxes, Processes, and Problems*. Thousand Oaks: SAGE Publications, p. 11.

European Commission. 1999. *European Spatial Development Perspective: Towards Balanced and Sustainable Development of the Territory of EU*. Luxembourg: Publications Office for the European Union.

Ewing, Reid. 1997. Is Los Angeles-style sprawl desirable? *Journal of the American Planning Association* 63: 107–26. [CrossRef]

Farmer, Jane, Amy Nimegeer, John H. Farrington, and Gaener Rodger. 2012. Rural citizens' rights to accessible health services: An exploration. *Sociologia Ruralis* 52: 134–44. [CrossRef]

Farrell, Chad R. 2016. Immigrant suburbanisation and the shifting geographic structure of metropolitan segregation in the United States. *Urban Studies* 53: 57–76. [CrossRef]

Fotheringham, A. Stewart, and Mehak Sachdeva. 2022. On the importance of thinking locally for statistics and society. *Spatial Statistics* 50: 100601. [CrossRef]

Fotheringham, A. Stewart, Chris Brunsdon, and Martin Charlton. 2003. *Geographically Weighted Regression: The Analysis of Spatially Varying Relationships*. Hoboken: Wiley & Sons.

Gesano, Giuseppe, and Salvatore Strozza. 2011. Foreign migrations and population aging in Italy. *Genus* 67: 83–104.

Getis, Arthur, and Keith J. Ord. 1992. The analysis of spatial association by use of distance statistics. *Geographical Analysis* 24: 189–206. [CrossRef]

Geurs, Karst T., and Bert van Wee. 2004. Accessibility evaluation of land-use and transport strategies: Review and research directions. *Journal of Transport Geography* 12: 127–40. [CrossRef]

Geurs, Karst T., and Jan R. Ritsema van Eck. 2001. *Accessibility Measures: Review and Applications. Evaluation of Accessibility Impacts of Land-Use Transportation Scenarios, and Related Social and Economic Impact*. RIVM Rapport 408505006. Bilthoven: National Institute for Public Health and the Environment.

Glaeser, Edward L., Jose A. Scheinkman, and Andrei Shleifer. 1995. Economic growth in a cross-section of cities. *Journal of Monetary Economics* 36: 117–43. [CrossRef]

Golini, Antonio, Antonio Mussino, and Mira Savioli. 2000. *Il Malessere Demografico in Italia. Una Ricerca sui Comuni Italiani*. Bologna: Il Mulino.

Graham, Daniel J., and Stephen Gibbons. 2019. Quantifying wider economic impacts of agglomeration for transport appraisal: Existing evidence and future directions. *Economics of Transportation* 19: 100121. [CrossRef]

Graves, Philip E. 1983. Migration with a composite amenity: The role of rents. *Journal of Regional Science* 23: 541–46. [CrossRef]

Gutiérrez, Javier, Ana Condeço-Melhorado, and Juan Carlos Martín. 2010. Using accessibility indicators and GIS to assess spatial spillovers of transport infrastructure investment. *Journal of Transport Geography* 18: 141–52. [CrossRef]

Haartsen, Tialda, and Viktor Venhorst. 2010. Planning for decline: Anticipating on population decline in the Netherlands. *Tijdschrift Voor Economische en Sociale Geografie* 101: 218–27. [CrossRef]

Handy, Susan L., and Debbie A. Niemeier. 1997. Measuring accessibility: An exploration of issues and alternatives. *Environment and planning A* 29: 1175–94. [CrossRef]

Hansen, Walter G. 1959. How accessibility shapes land use. *Journal of the American Institute of Planners* 25: 73–76. [CrossRef]

Harper, Sarah. 2014. Economic and social implications of aging societies. *Science* 346: 587–91. [CrossRef]
Hiebert, Daniel. 2000. Immigration and the changing Canadian city. *Canadian Geographer/Le Géographe Canadien* 44: 25–43. [CrossRef]
Iammarino, Simona, Andrés Rodriguez-Pose, and Michael Storper. 2019. Regional inequality in Europe: Evidence, theory and policy implications. *Journal of Economic Geography* 19: 273–98. [CrossRef]
Isserman, Andrew M., Edward Feser, and Drake E. Warren. 2009. Why some rural places prosper and others do not. *International Regional Science Review* 32: 300–42. [CrossRef]
ISTAT. 2023. *L'Accessibilità dei Comuni alle Principali Infrastrutture di Trasporto*. Rome: Statistiche Focus.
Karou, Saleem, and Angela Hull. 2014. Accessibility modelling: Predicting the impact of planned transport infrastructure on accessibility patterns in Edinburgh, UK. *Journal of Transport Geography* 35: 1–11. [CrossRef]
Kazemipur, Abdolmohammad, and Shiva Halli. 2000. The invisible barrier: Neighbourhood poverty and integration of immigrants in Canada. *Journal of International Migration and Integration/Revue de l'Integration et de la Migration Internationale* 1: 85–100. [CrossRef]
Kneebone, Elizabeth, and Emily Garr. 2010. *The Suburbanization of Poverty*. Washington, DC: Brookings Institute.
La Bianca, Marilena, and Francisco Navarro Valverde. 2019. Depopulation and aging in rural areas in the European Union: Practicing starting from the LEADER approach. *Perspectives on Rural Development* 3: 223–52.
Litman, Todd. 2015. *Evaluating Public Transit Benefits and Costs*. Victoria: Victoria Transport Policy Institute.
Lo, Lucia, Amir Shalaby, and Baha Alshalalfah. 2011. Relationship between immigrant settlement patterns and transit use in the Greater Toronto Area. *Journal of Urban Planning and Development* 137: 470–76. [CrossRef]
Lucas, Karen. 2012. Transport and social exclusion: Where are we now? *Transport Policy* 20: 105–13. [CrossRef]
Lundberg, Johan. 2006. Spatial interaction model of spillovers from locally provided public services. *Regional Studies* 40: 631–44. [CrossRef]
Matthews, Stephen A., and Daniel M. Parker. 2013. Progress in spatial demography. *Demographic Research* 28: 271–312. [CrossRef]
Matthews, Stephen A., and Tse-Chuan Yang. 2012. Mapping the results of local statistics: Using geographically weighted regression. *Demographic Research* 26: 151–66. [CrossRef]
Melo, Patricia C., Conceiccao Rego, Paulo R. Anciães, Nuno Guiomar, and Josè Muñoz-Rojas. 2022. Does road accessibility to cities support rural population growth? Evidence for Portugal between 1991 and 2011. *Journal of Regional Science* 62: 443–70. [CrossRef]
Moran, Patrick A.P. 1948. The interpretation of statistical maps. *Journal of the Royal Statistical Society B* 10: 243–51. [CrossRef]
Moya-Gómez, Borja, Maria Henar Salas-Olmedo, Juan Carlos García-Palomares, and Javier Gutiérrez. 2018. Dynamic accessibility using big data: The role of the changing conditions of network congestion and destination attractiveness. *Networks and Spatial Economics* 18: 273–90. [CrossRef]
Muti, Ördecan. 2023. Regional Population Diversity and Social Cohesion in the Local Context. Population Policy Discussion Paper, 20. Available online: https://population-europe.eu/files/documents/dp_reg_pop_div_web_18.07.pdf (accessed on 5 September 2024).
Neumeier, Stefan. 2016. Accessibility to services in rural areas. *disP–The Planning Review* 52: 32–49. [CrossRef]
OECD, The European Commission, Food and Agriculture Organization of the United Nations, United Nations Human Settlements Programme, International Labour Organization, and The World Bank. 2021. Applying the Degree of Urbanisation: A Methodological Manual to Define Cities, Towns and Rural Areas for International Comparisons. In *OECD Regional Development Studies*. Paris: OECD Publishing. Brussels: European Union. [CrossRef]
Ord, Keith J., and Arthur Getis. 1995. Local spatial autocorrelation statistics: Distributional issues and an application. *Geographical Analysis* 24: 286–306. [CrossRef]
Oshan, Taylor M., Ziqi Li, Wei Kang, Levi J. Wolf, and A. Stewart Fotheringham. 2019. Mgwr: A Python implementation of multiscale geographically weighted regression for investigating process spatial heterogeneity and scale. *ISPRS International Journal of Geo-Information* 8: 269. [CrossRef]
Ozbay, Kaan, Dilruba Ozmen, and Joseph Berechman. 2006. Modeling and analysis of the link between accessibility and employment growth. *Journal of Transportation Engineering* 132: 385–93. [CrossRef]
Panagiotopoulos, George, and Dimitris Kaliampakos. 2024. Accessibility, rural depopulation & the Modified Areal Unit Problem: An analysis of mainland Greece. *European Journal of Geography* 15: 42–53.
Partridge, Mark D., Dan S. Rickman, Kamar Ali, and M. Rose Olfert. 2008. The geographic diversity of US nonmetropolitan growth dynamics: A geographically weighted regression approach. *Land Economics* 84: 241–66. [CrossRef]
Patuelli, Roberto, Aura Reggiani, Sean P. Gorman, Peter Nijkamp, and Franz-Josef Bade. 2007. Network analysis of commuting flows: A comparative static approach to German data. *Networks and Spatial Economics* 7: 315–31. [CrossRef]
Rasker, Ray, Patricia H. Gude, Justin A. Gude, and Jeff Van den Noort. 2009. The economic importance of air travel in high-amenity rural areas. *Journal of Rural Studies* 25: 343–53. [CrossRef]
Rees, Philip, Nicole van der Gaag, Joop de Beer, and Frank Heins. 2012. European regional populations: Current trends, future pathways and policy options. *European Journal of Population* 28: 385–416. [CrossRef]
Reitz, Jeffrey G. 2002. Host societies and the reception of immigrants: Research themes, emerging theories and methodological issues. *International Migration Review* 36: 1005–19. [CrossRef]
Reynaud, Cecilia, and Sara Miccoli. 2023. Demographic sustainability in Italian territories: The link between depopulation and population ageing. *Vienna Yearbook of Population Research* 21: 1–22. [CrossRef]

Reynaud, Cecilia, Sara Miccoli, Federico Benassi, Alessia Naccarato, and Luca Salvati. 2020. Unravelling a demographic 'Mosaic': Spatial patterns and contextual factors of depopulation in Italian Municipalities, 1981–2011. *Ecological Indicators* 115: 106356. [CrossRef]

Roback, Jennifer. 1982. Wages, rents, and the quality of life. *Journal of political Economy* 90: 1257–78. [CrossRef]

Rodríguez-Rodríguez, David, and Remedios Larrubia Vargas. 2022. Protected areas and rural depopulation in Spain: A multi-stakeholder perceptual study. *Land* 11: 384. [CrossRef]

Rosina, Alessandro, and Roberto Impicciatore. 2022. *Storia Demografia d'Italia. Crescita, Crisi e Sfide*. Rome: Carocci, pp. 1–187.

Salvati, Luca. 2014. Population distribution and urban growth in Southern Italy, 1871–2011: Emergent polycentrism or path-dependent monocentricity? *Urban Geography* 35: 440–53. [CrossRef]

Sánchez-Mateos, Martínez, and Ruiz A. R. Pulpón. 2021. Closeness is not accessibility: Isolation and depopulated rural areas in the proximity of metropolitan urban areas, a case-study in inland Spain. *European Countryside* 13: 410–35. [CrossRef]

Shelukdov, Alexander, Johannes Kamp, and Daniel Müller. 2020. Decreasing labor intensity in agriculture and the accessibility of major cities shape the rural population decline in postsocialist Russia. *Eurasian Geography and Economics* 62: 481–506.

Solé-Ribalta, Albert, Sergio Gómez, and Alex Arenas. 2018. Decongestion of urban areas with hotspot pricing. *Networks and Spatial Economics* 18: 33–50. [CrossRef]

Staniscia, Barbara, and Federico Benassi. 2018. Does regional development explain international youth mobility? Spatial patterns and global/local determinants of the recent emigration of young Italians. *Belgeo. Reveu Belge de Géographie* 3: 1–25.

Stepniak, Marcin, and Piotr Rosik. 2018. The role of transport and population components in change in accessibility: The influence of the distance decay parameter. *Networks and Spatial Economics* 18: 291–312. [CrossRef]

Strozza, Salvatore, Federico Benassi, Raffaele Ferrara, and Gerardo Gallo. 2016. Recent demographic trends in the major Italian urban agglomerations: The role of foreigners. *Spatial Demography* 4: 39–70. [CrossRef]

Termote, Marc. 2005. Implicazioni urbane dei mutamenti demografici e economici nei paesi sviluppati. Il caso Italiano. *Rivista Italiana di Economia, Demografia e Statistica* 54: 75–85.

Thompson, Chris, and Tim Bawden. 1992. What are the potential economic development impacts of high-speed rail? *Economic Development Quarterly* 6: 297–319. [CrossRef]

Tragaki, Alexandra, and Antonis Rovolis. 2014. Immigrant population in Italy during the first decade of the 21st century: Changing demographics and modified settlement patterns. *European Urban and Regional Studies* 21: 286–300. [CrossRef]

Van den Heuvel, Frank P., Liliana Rivera, Karel H. Van Donselaar, Ad de Jong, Yossi Sheffi, Peter W. de Langen, and Jan C. Fransoo. 2014. Relationship between freight accessibility and logistics employment in US counties. *Transportation Research Part A: Policy and Practice* 59: 91–105. [CrossRef]

Vickerman, Roger. 1974. Accessibility, attraction, and potential: A review of some concepts and their use in determining mobility. *Environment and Planning A* 6: 675–91. [CrossRef]

Vickerman, Roger, Klaus Spiekermann, and Michael Wegener. 1999. Accessibility and economic development in Europe. *Regional Studies* 33: 1–15. [CrossRef]

Viesti, Gianfranco. 2021. *Centri e Periferie: Europa, Italia, Mezzogiorno dal XX al XXI Secolo*. Bari: Giuseppe Laterza e Figli.

Voss, Paul R., and Guangqing Chi. 2006. Highways and population change. *Rural Sociology* 71: 33–58. [CrossRef]

Wang, Qingfang. 2008. Race/ethnicity, gender and job earnings across metropolitan areas in the United States: A multilevel analysis. *Urban Studies* 45: 825–43. [CrossRef]

Wolff, Manuel, and Thorsten Wiechmann. 2018. Urban growth and decline: Europe's shrinking cities in a comparative perspective 1990–2010. *European Urban and Regional Studies* 25: 122–39. [CrossRef]

Yu, Hanchen, A. Stewart Fotheringham, Ziqi Li, Taylor Oshan, Wei Kang, and Levi John Wolf. 2020. Inference in multiscale geographically weighted regression. *Geographical Analysis* 52: 87–106. [CrossRef]

Zambon, Ilaria, Kostas Rontos, Cecilia Reynaud, and Luca Salvati. 2020. Toward an unwanted divided? Fertility decline and the North-South divide in Italy, 1952–2018. *Quality and Quantity* 54: 169–87. [CrossRef]